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(54) CASTING MOLTEN METALS

(71) We, FOSECO INTERNATIONAL LIMITED, a British Company of Long Acre, Nechells, Birmingham, B7 5JR, England, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to casting molten metals to form ingots.

There are two principal methods of pouring molten metal to cast ingots, top pouring and bottom pouring. Top pouring is simple to carry out but has several disadvantages. The molten metal is subject to considerable turbulence, splashing takes place and as a result there is a tendency for non-metallic inclusions to become entrapped in the molten metal. Additionally, the ingot mould is subjected to highly erosive forces which tend to reduce the life of the mould or baseplate thereof.

Bottom pouring avoids these disadvantages but is generally inconvenient to use and requires the provision of much equipment and setting up the moulds requires more time and labour.

Once molten metal has been cast into an ingot mould by top or bottom pouring, during solidification, the molten metal shrinks. This can lead to cracks and fissures in the ingot, known as pipe, unless the head metal is kept molten. Keeping the head metal molten allows feed of molten metal from the head to the remainder of the ingot to compensate for shrinkage and the final solid ingot is free of pipe. A common way of ensuring that the head metal of the ingot stays molten for a sufficient length of time is to insulate the head metal by the provision of a so-called hot top in the upper part of the mould or in a headbox superimposed on the mould. Such a hot top generally has a lining of heat-insulating refractory material which serves to reduce lateral heat flow away from the head metal. However, merely reducing lateral heat flow does not in some cases give satisfactory results since the head metal still solidifies too soon. It is thus known to apply, after teeming has finished, heat-insulating refractory or heat producing, i.e. exothermic, covers to the upper surface of the molten metal in the mould, either in the form of a coherent body or in the form of unbonded material. Such materials are known as "anti-piping" compounds.

The application of such anti-piping compounds is often difficult. In order to ensure that they are of maximum effect, they must be applied immediately teeming has ceased and therefore generally while teeming is taking place in a nearby ingot mould with consequent risk of injury to the operators from molten metal or splashing or the like. In addition, at this stage, the problem ingot is at its hottest and therefore at its least approachable.

We have now found that these various disadvantages may be overcome or reduced in effect and at the same time a cover positioned on the molten ingot to reduce heat loss by use of an assembly of a particular type located in the ingot mould prior to pouring molten metal therein.

According to the present invention there is provided a method ofcasting molten metal to form an ingot which comprises locating in an ingot mould a substantially vertical tube of fibrous material of melting point less than the casting temperature of the molten metal and which, under the action of the heat of the molten metal, forms a casting flux and mould wall coating in the mould during casting, locating at or near one end of the tube a collar of material which under the action of the heat of the molten metal, disintegrates to form a cover of anti-piping compound over the exposed molten metal surface at the termination of teeming, teeming molten metal into the mould to melt the tube and disintegrate the collar to form the cover of anti-piping compound and allowing the molten metal to solidify in the mould.

During teeming, as the molten metal surface rises up the mould, the fibrous tube slowly melts and the melted tube flows over

the surface of the molten metal to form a casting flux and a mould wall coating. If top pouring is used, the molten metal should, of course, be teemed through the tube.

Suitable inorganic fibres for making the tube are calcium or aluminium silicate fibres or glass fibres. Commercially available impure materials such as rock wool or slag wool may be used. The tube may be of felted or bonded fibre and the material of the tube may contain other ingredients to enhance the fluxing action. The tube may be in one piece or made up of a plurality of sections suitably fitted or attached together, e.g. by means of clips or adhesive. The tube may be of circular or other convenient cross-section such as a rectangular, triangular or polygonal, e.g. octagonal, cross-section and may be made up from arcuate sections if desired. The material of the tube may also contain ingredients to perform effects other than fluxing, for example, ingredients which can generate a non-oxidising atmosphere over the rising metal surface and thus reduce the number of oxide inclusions in the final cast ingot, ingredients which have a fluidising effect on metallic oxides, and ingredients which can aid the formation of a satisfactory heat-insulating layer on the top of the molten metal surface when teeming has finished.

The collar of material which, on contact with the molten metal, can disintegrate to form a layer of anti-piping compound may be made from a wide variety of materials, and typically may be a material consisting essentially of a heat-insulating refractory material, a heat-expandable material, e.g. expandable graphite, a fibrous material (to provide strength) and a binding agent. Alternatively, a proportion or all of the heat-insulating refractory material may be replaced by one or more exothermically reacting materials such as an alumino-thermic composition comprising an oxidisable substance, an oxidising agent and optionally an inert filler.

If desired, that part of the collar which is the underside in use may be faced with a heat-reflective layer to prevent premature disintegration under the effect of radiant heat from the rising metal surface.

The assembly of tube and collar may be held in place in the mould by any suitable arrangement, typically an arrangement of clips or stays, and conveniently one chosen to be of sufficient strength that the assembly is not dislodged easily during handling of the ingot mould prior to casting or by molten metal splashes or impingement.

The invention is illustrated, by way of example with reference to the accompanying drawings which shows an assembly for use in an ingot mould for casting in accordance with the method of the present invention.

Referring to the drawing, an assembly consists of a fibre tube 1, having an upper collar formed of a square plate 2 having an aperture therein. Plate 2 is supportable by means of four location clips 3 which are adapted to rest on the top of the walls of an ingot mould body and to be bent over to engage firmly thereon. The tube and collar are held together by metal clips.

By way of example the tube 1 may be made of a composition comprising the following ingredients within the following general range (% by weight):

calcium silicate fibre ...	10—60%,	typically 10—40%
blast furnace slag (crushed)	10—60%,	typically 10—40%
fluorspar	5—20%,	typically 5—15%
organic fibre (e.g. paper pulp)	1— 5%	
binder	4— 7%	

A typical composition for the collar 2 is (% by weight):

alumina-containing refractory materials	71%
oxidisable metal	3%
oxidising agent	3%
expandable graphite	5%
inorganic fibrous material ...	12%
binding agent	6%

Clips 3 are suitably made of 14 gauge mild steel.

The method of the present invention uses an assembly which is easy to set up and leads to ingots which are pipe free and of high surface quality. In addition, use of the method of the invention can avoid the risk of operatives being injured e.g. by molten metal splashes shortly after teeming of a particular ingot mould has finished. Further, in the case of bottom pouring, it is ensured that the application of the anti-piping compound takes place simultaneously for all the ingots cast in a bottom poured assembly in which several ingots are fed simultaneously from one pouring trumpet.

WHAT WE CLAIM IS:—

1. A method of casting molten metal to form an ingot which comprises locating in an ingot mould a substantially vertical tube of fibrous material of melting point less than the casting temperature of the molten metal and which, under the action of the heat of the molten metal, forms a casting flux and mould wall coating in the mould during casting, locating at or near one end of the tube a collar of material which under the action of the heat of the molten metal,

disintegrates to form a cover of anti-piping compound over the exposed molten metal surface at the termination of teeming, teeming molten metal into the mould to melt the tube and disintegrate the collar to form the cover of anti-piping compound and allowing the molten metal to solidify in the mould.

2. A method according to claim 1, wherein the fibrous material of the tube comprises calcium or aluminium silicate fibres or glass fibres.

3. A method according to claim 1, wherein the fibrous material of the tube comprises rock wool or slag wool.

4. A method according to any one of the preceding claims wherein the tube is of felted fibre.

5. A method according to any one of claims 1 to 3, wherein the tube is of bonded fibre.

6. A method according to any one of the preceding claims wherein the tube is made up of a plurality of sections fitted or attached together.

7. A method according to any one of the preceding claims wherein the collar is of a material consisting essentially of a refractory material, a heat-expandable material, a fibrous material and a binding agent.

8. A method according to any one of the preceding claims, wherein that part of the collar which is the underside is faced with a heat-reflective layer.

9. A method according to any one of the preceding claims which includes arranging clips or stays to hold the assembly in place in the ingot mould.

10. A method according to any one of the preceding calims, wherein the material of the tube contains one or more ingredients which, during casting, generate a non-oxidising atmosphere, one or more ingredients which have a fluidising effect on metallic oxides, and/or one or more ingredients which can aid the formation of a heat-insulating layer on top of a molten metal surface.

11. A method according to any one of the preceding claims wherein the collar is made of a composition comprising the following ingredients (% by weight):

alumina-containing refractory materials	71%
oxidisable metal	3%
oxidising agent	3%
expandable graphite	5%
inorganic fibrous material ...	12%
binding agent	6%

12. A method according to any one of the preceding claims, wherein the tube is of circular cross-section.

13. A method according to any one of claims 1 to 11, wherein the tube is of rectangular, triangular or polygonal cross-section.

14. A method according to any one of the preceding claims, wherein the tube is made of a composition comprising the following ingredients within the following general ranges (% by weight):

calcium silicate fibre ...	10—60%
blast furnace slag (crushed)	10—60%
fluorspar	5—20%
organic fibre	1— 5%
binder	4— 7%

15. A method according to any one of claims 1—14, wherein the metal is top poured through the tube of the assembly.

16. A method according to claim 1 and substantially as hereinbefore described with reference to the accompanying drawing.

17. An ingot when cast by a method as claimed in any one of claims 1 to 16.

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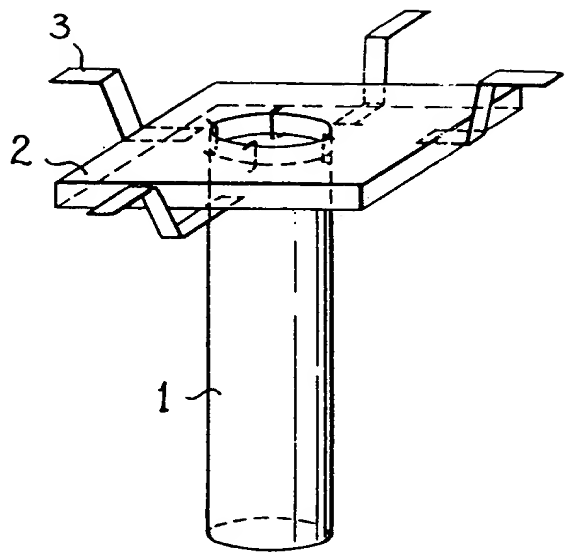
1473908 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*



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